ORIGINAL ARTICLE

Factors associated with post-exertional malaise in persons living with long COVID: A mixed-methods study

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ABSTRACT

Post-COVID syndrome is a significant problem commonly encountered after contracting a COVID-19 infection. Post-exertional malaise (PEM) is a particularly debilitating symptom of post-COVID syndrome. This explanatory sequential mixed-method research aimed to study factors influencing the occurrence of PEM in post-COVID-19 patients. The sample group consisted of 98 post-COVID-19 patients receiving treatment at Phrachomklao Hospital, Phetchaburi Province, Thailand, selected through simple random sampling for a quantitative study, and 30 post-COVID-19 patients were selected based on purposive criteria for the qualitative study. Data were collected through questionnaires for the quantitative part and face-to-face in-depth interviews for the qualitative part. Data analysis involved descriptive statistics, multiple regression analysis, and content analysis. The results revealed that all members of the sample group exhibited more than one post-COVID syndrome symptom. The most prevalent physical symptoms reported were fatigue (87.76%), exhaustion after activities (73.47%), and chronic cough (67.35%). Regarding mental, emotional, and social symptoms, the chief one reported was fear (74.49%), followed by stress (68.37%), and anxiety (53.06%). The overall assessment of PEM in post-COVID patients revealed an average fatigue level of 4.09 (M = 4.09, SD = 0.78), indicating moderate fatigue. Several factors together, including Body Mass Index (BMI) (β=0.378, $p < 0.001$), female sex (β=0.376, $p < 0.001$), and the severity of the COVID-19 illness (β=0.172, $p < 0.05$), predicted the presence of PEM in post-COVID patients ($R2 = 0.441$, $p < 0.05$). The qualitative analysis provided deeper insights into the lived experiences of post-COVID patients, highlighting themes such as physical and emotional exhaustion, challenges in daily activities, and the psychological impact of persistent symptoms. These results increase our understanding of PEM in long COVID patients and underscore the need for tailored healthcare services to support recovery, particularly for those at higher risk. Healthcare providers should develop service systems to provide post-fatigue care, especially for obese and severely ill COVID-19 patients.

Key words:
post-exertional malaise; long COVID; mixed-method study

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INTRODUCTION

The global COVID-19 pandemic has significantly affected public health, economies, and societies worldwide. [1-3] Approximately 5-8 % of COVID-19 patients develop severe symptoms, particularly involving the lungs[1]. Previous studies indicate that 7.5-17.6% of COVID-19 patients require hospital readmission.[4,5] These patients experienced persistent symptoms lasting more than four weeks, and which were unrelated to reinfection or new viral stimulation. These symptoms together were defined as "Long COVID" or "Post-COVID-19 syndrome".[6-8] The World Health Organization defines post-COVID-19 conditions as symptoms occurring after COVID-19 infection, occurring predominantly within three months after infection, and lasting at least two months.[9] Common symptoms included fatigue, breathlessness, cognitive dysfunction, and impaired ability to perform daily activities. Furthermore, symptoms may persist for more than one year.[10.]

Post-exertional malaise (PEM), characterized by fatigue or exhaustion after activity, is frequently observed in individuals after recovering from COVID-19.[11] A long-term study has provided in-depth insights into the pathophysiology of post-exertional malaise in COVID-19 long-haulers. It was found that the pathophysiology of PEM includes acute symptoms from exertion that decrease the function of muscle enzyme mitochondria, amyloid accumulation in muscles, severe muscle tissue damage, and the impact of increased T-cell responses to muscle injury from exercise.[12]

The prominent symptoms experienced by long COVID patients include PEM, which is associated with fatigue and post-exercise pain without apparent pathological features. According to a systematic review of 25 survey-based studies, post-COVID patients commonly experience symptoms such as chest pain, fatigue, breathlessness, and coughing, with the prevalence ranging from 4.7% to 80%.[13] Carfì et al. found that around 76-87% of patients suffering from COVID-19 experience abnormal symptoms, such as joint pain, muscle pain, insomnia, loss of appetite, sore throat, dizziness, or diarrhea.[14] These symptoms can persist even after the patient has recovered from the virus and can lead to various mental health issues such as anxiety, depression, social isolation, and post-illness stress disorder[6,15] and also impact a patient's ability to work, potentially leading to economic problems.[16] Therefore, PEM after contracting COVID-19 is a crucial problem that healthcare professionals should address by providing appropriate care to patients following their recovery from COVID-19.

From the literature review, few studies have focused directly on PEM in post-COVID-19 patients and its associated factors. A quantitative survey of long-term COVID-19 in Thailand investigated the prevalence of post-infection sequelae among 202 patients three months after infection. It found that common symptoms included hair loss, post-exertional malaise, difficulty breathing, fatigue, and insomnia. Moreover, the severity of the symptoms during the infection and comorbidities such as diabetes are associated with developing breathing difficulties.[17] Additionally, Channanrong et al. found that age, occupation, underlying diseases, and severity of illness were related to post-discharge lingering symptoms from hospitals.[18] Some studies found that factors related to long COVID include both personal characteristics such as age, sex, occupation, and health-related factors such as body mass index, comorbidities, and severity of illness.[19,20] Additionally, a study at Kasetsart University reported that people experienced significant long COVID symptoms, which further emphasizes the widespread impact of these symptoms across different populations.[21] Vaccination

is expected to reduce the symptoms of COVID-19 and can decrease the occurrence of long COVID.[22]

Therefore, this research aimed to study the signs and symptoms of patients with long COVID who were receiving treatment at the primary care unit of Phrachomklao Hospital, Phetchaburi province, Thailand. We also assessed the fatigue severity of PEM in patients with long COVID-19. Finally, we examined which factors predicted the occurrence of PEM in individuals with long COVID, including age, gender, occupation, body mass index, comorbidities, COVID-19 vaccination, and severity of COVID-19 illness.

METHODS

Design

This study used an explanatory sequential mixed methods approach, conceptualized by Creswell & Clark, involving quantitative and qualitative research processes.[23] We began with quantitative research to gather data. Then, we used these findings to inform the design of qualitative interviews. Subsequently, the study integrated and synthesized quantitative and qualitative data to analyze and draw conclusions. The design of this research can be seen in Figure 1.

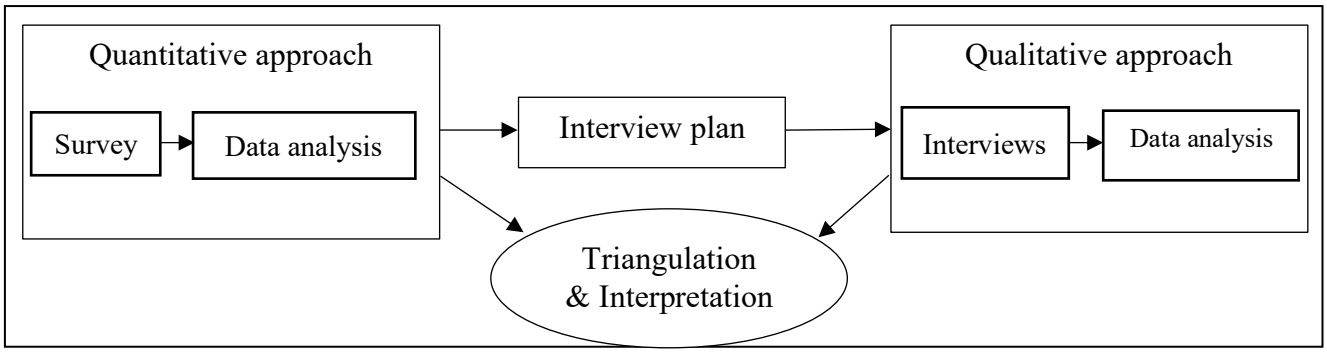


Figure 1. Research Design (Explanatory sequential mixed methods design)

Sample/Participants

The population refers to 146 individuals who were diagnosed with post-COVID-19 syndrome by a physician between December 2022 and November 2023. All participants received care at the primary care unit of Phrachomklao Hospital, Phetchaburi province.

The sample was divided into two groups: one for quantitative data collection and the other for qualitative data collection. The sample size necessary for quantitative data collection was determined using the G*Power version 3.1.9.7 software.[24] We set a medium effect size of 0.15[25], a significance level (α) of 0.05, and a power of test (1-β) of 0.80. The calculated sample size was 98 individuals. To account for potential non-response bias, we estimated an additional 10%, resulting in a total sample size of approximately 108 individuals. We recruited participants for the quantitative part of our study through simple random sampling, using a random number generator to select participants from a list of eligible post-COVID-19 patients who met the study criteria. The inclusion criteria for selecting research volunteers included: 1) were diagnosed by a physician with post-COVID-19 syndrome; 2) aged 20 years or over; 3)

could communicate in Thai, and 4) were willing to participate in the study.

The inclusion criteria for volunteers in the qualitative data collection included: 1) were diagnosed by a physician with post-COVID-19 syndrome; 2) aged 20 years or over; 3) had responded to the research questionnaire in Step 1; 4) scored a total fatigue score of 4 or above for after activities; 5) had a body mass index (BMI) greater than or equal to 23 kilograms per square meter, and 6) were willing to participate in the research. This qualitative component involved 30 participants, with data saturation achieved during the analysis.[25]

Research instruments

The research instruments created by the researchers through the literature review consisted of:

1. A personal and health status questionnaire comprising 11 questions, including age, sex, weight, height, BMI, underlying health conditions, occupation, history of COVID-19 vaccination, history of COVID-19 illness, and severity of illness categorized according to the World Health Organization.[9]

2. The questionnaire on long COVID-like symptoms consisted of 27 symptoms developed by the researchers, identified from a review of the literature on COVID-19 symptoms.[6-10] The content validity was evaluated by a panel of three experts specializing in the care of COVID-19 patients. Participants were asked to indicate whether they had each symptom or not. The content validity index was 1.00. The Cronbach's alpha reliability coefficient was 0.81.

3. The Fatigue Severity Scale (FSS) was an assessment developed by Krupp et al.[27] It was translated into Thai by Sawasdee et al.[28] The 7-point Likert scale used in the study consists of nine questions, with scores ranging from 1 to 7, where one indicated "strongly disagree" and seven indicated "strongly agree." A score of FSS ≥ 4 indicated the presence of fatigue, with higher scores indicating greater fatigue. The questionnaire had a content validity index of 1.00. The Cronbach's alpha reliability coefficient was 0.97.

4. The open-ended questions were designed for use in face-to-face in-depth interviews regarding the experiences of post-activity fatigue among COVID-19 patients. These questions were formulated based on the long COVID symptoms and fatigue assessment findings in the 1st and 2nd research objectives.

Ethical approval

This study was conducted according to the Declaration of Helsinki and approved by the Research Ethics Committee of PHRACHOMKLAO HOSPITAL, with reference number 9/2565 and a date of approval of November 22, 2022.

Data Collection

The researchers collected data between December 2022 and November 2023. We gathered data from long COVID patients receiving services at the primary care unit of Phrachomklao Hospital.

Statistical Analysis

1. Personal and health status data and data on signs and symptoms of post-COVID fatigue were analyzed using frequency statistics, percentages, means, and standard deviations.

2. Quantitative data regarding factors affecting PEM in COVID-19 patients were analyzed using stepwise multiple regression analysis. Preliminary assumptions for statistical analysis, including normality, linearity, homoscedasticity, and multicollinearity, were tested and confirmed to meet the necessary criteria without violations. The residuals were normally distributed, relationships between independent variables and the dependent variable were linear, the residuals exhibited constant variance, and there was no significant

multicollinearity among the independent variables, as indicated by acceptable VIF values.[29]

3. Qualitative data concerning the experiences of post-COVID fatigue in patients after activity were analyzed using content analysis.[30] Each participant was interviewed once, with sessions lasting approximately 30 to 45 minutes, until data saturation was reached. Finally, we synthesized the quantitative and qualitative data to conclude the factors influencing post-activity fatigue in long COVID patients.

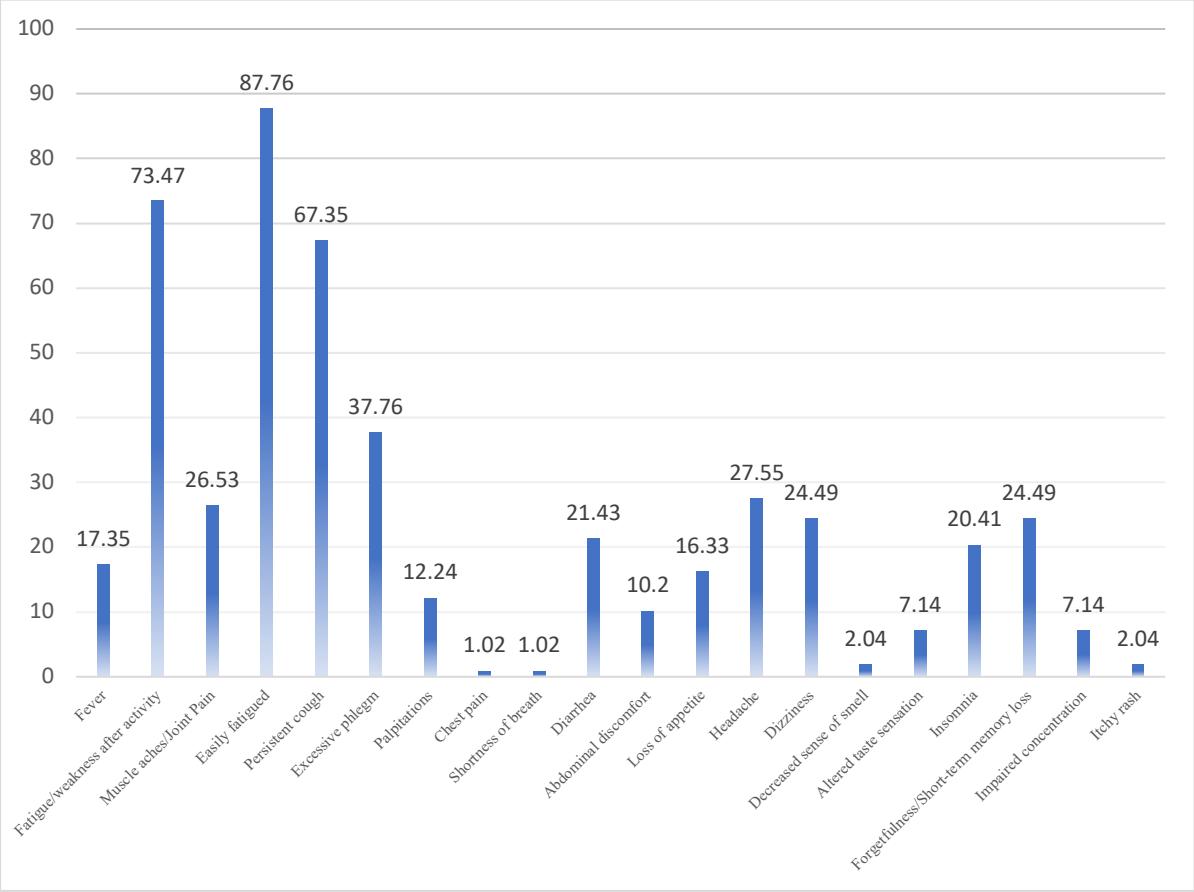
RESULTS

Quantitative Results

The complete questionnaire was returned by 98 individuals surveyed. The majority were female (53.06%), with an average age of 46.71 years (SD = 16.78). Regarding COVID-19 vaccination history, the highest frequency was receiving three doses (71.43%). Half of the sample group had underlying health conditions (50%), with the highest frequency being hypertension (24.49%), followed by diabetes comorbid with hypertension (22.45%). Concerning body mass index, 38.78% had a normal BMI, while 23.47% were classified as obese level 1. Regarding the severity of COVID-19 symptoms, the majority experienced moderate symptoms (46.94%), while a minority had severe symptoms with pneumonia (12.24%).

Signs and symptoms of long COVID patients

Upon examination of the signs and symptoms of the sample group suspected to have long COVID syndrome, we found a high prevalence of physical symptoms, with the most common being fatigue (87.76%), followed by weakness or fatigue after activity (73.47%), and chronic cough (67.35%), as depicted in Figure 2. Psychological and social symptoms, as shown in Figure 3, revealed that fear was the most prevalent (74.49%), followed by anxiety (68.37%). The distribution of fatigue severity scores indicated that 61.22% of patients experienced significant fatigue, as illustrated in Figure 4. Finally, Figure 5 depicts the duration of long COVID symptoms, revealing that a majority of patients (66.37%) reported symptoms lasting 2-3 months, while 26.53% experienced symptoms for more than 3-6 months.



Note: Everyone in the sample group experienced more than one symptom.

Figure 2. Prevalence of Physical Symptoms in Long COVID Patients

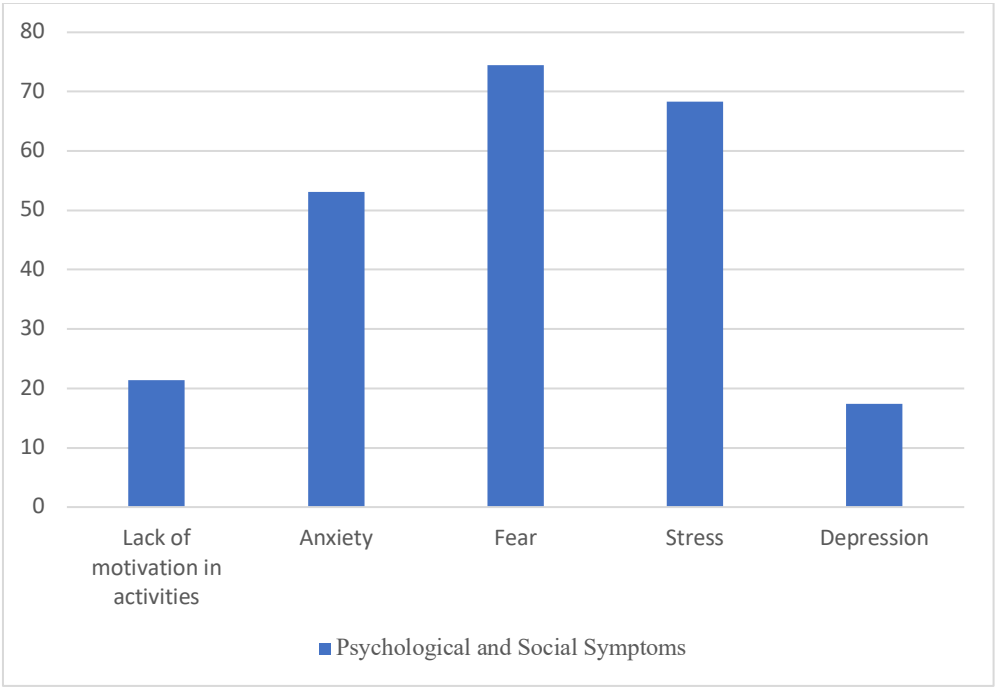


Figure 3. Prevalence of Psychological and Social Symptoms in Long COVID Patients

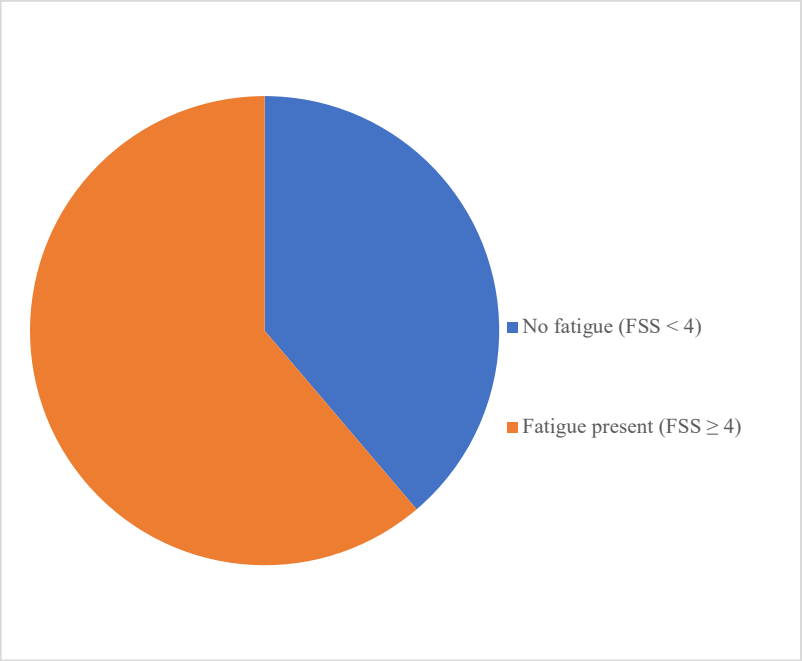


Figure 4. Fatigue Severity Score

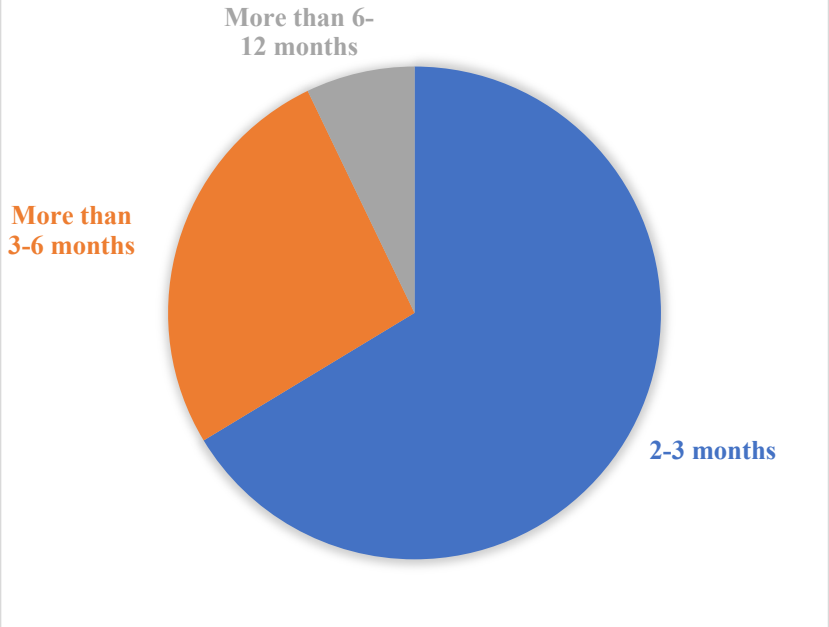


Figure 5. Duration f Long COVID Symptoms

Post-exertional malaise (PEM) in patients with long COVID

Overall assessment of PEM in patients with long COVID revealed the presence of fatigue (*Mean* = 4.09, *SD* = 0.78). When considering individual items, the highest mean was observed for "Exercise brings on my fatigue" (*Mean* = 5.09, *SD* = 1.06). The lowest mean was noted for "Fatigue interferes with my work, family, or social life " (*Mean* = 3.63, *SD* = 1.01) (Table 1).

Table 1 Fatigue score of patients with long COVID (n=98)

Fatigue assessment	*Mean*	*SD*
1. My motivation is lower when I am fatigued.	4.18	1.11
2. Exercise brings on my fatigue.	5.09	1.06
3. I am easily fatigued.	4.60	1.00
4. Fatigue interferes with my physical functioning.	4.03	0.96
5. Fatigue causes frequent problems for me.	3.93	0.83
6. My fatigue prevents sustained physical functioning.	3.76	0.93
7. Fatigue interferes with carrying out certain duties and responsibilities.	3.80	0.99
8. Fatigue is among my three most disabling symptoms.	3.80	0.91
9. Fatigue interferes with my work, family, or social life.	3.63	1.01
Overall	4.09	0.78

Factors associated with post-exertional malaise in persons living with long COVID

Multiple regression analysis revealed that female sex, BMI, and severity of COVID-19 illness could collectively predict PEM in post-COVID-19 patients with statistical significance ($R^2 = 0.441, p < 0.05$). The variable with the greatest influence was BMI (*Beta* = 0.378, $p < 0.05$), followed by female sex (*Beta* = 0.376, $p < 0.05$) (Table 2).

Table 2 Multiple Regression Analysis of Factors Influencing Post-Activity Fatigue in Patients with Post-COVID-19 Syndrome

Variables	Unstandardized Coefficients		Standardized Coefficients	*t*	*p*-value
	B	*Std. Error*	*Beta*		
Female sex	0.581	0.127	0.376	4.559	<0.001
Severity of COVID-19 illness	0.198	0.096	0.172	2.066	0.042
Constant	1.695	0.370		4.585	<0.001

Note. $R = 0.664$, $R^2 = 0.441$, $F = 24.713$, $p < 0.05$

Qualitative Results

The quantitative research findings found that factors influencing PEM occurrence and experiences in long COVID patients included sex, BMI, and the severity level of COVID-19 illness. Using these findings, researchers selected a targeted sample group of 30 individuals for in-depth qualitative research. The sample was predominantly female (83.33%) with ages ranging from 29 to 85 years (M=51.10, SD=14.63) and BMIs ranging from 23.96 to 35.32 kg/m^2 (M=28.13, SD=3.09). The majority had pre-existing medical conditions (73.33%), with a small proportion of 6.67% being unvaccinated against COVID-19. Half of the sample experienced moderate COVID illness severity (50%), while the remainder experienced severe symptoms (26.67%). Post-activity fatigue scores ranged from 4.00 to 6.22 (M=4.84, SD=0.62).

The results indicated that post-COVID condition manifests as illness symptoms that persist for two months to one year after recovery, affecting patients physically, psychologically, and socially. Symptoms like post-exertional malaise can lead to anxiety, stress, and fear, reducing activity levels and increasing fatigue, which

impacts work and family economic status. The following points summarize the qualitative data from the in-depth interviews:

1. PEM experience

The participants reported experiencing symptoms affecting various systems, including: 1) respiratory system: easy fatigue, chronic cough (both dry and with phlegm), 2) cardiovascular system: palpitations, chest pain, 3) digestive system: loss of appetite, nausea, diarrhea, 4) musculoskeletal system: muscle aches, joint pain, 5) nervous system: forgetfulness, short-term memory loss, dizziness, lightheadedness, weakness, 6) integumentary system: hair loss, easy bruising, dry skin, 7) psychological and emotional symptoms: feeling tired, lack of motivation for various activities, avoidance of social interactions, fear, anxiety, and stress. These symptoms affect various systems in the body. Further evidence of patients experiencing PEM is included in the following quotes from participants:

1.1 Fatigue and weakness: After recovering from COVID-19, patients reported feeling easily tired and weak, experiencing fatigue during various activities, and not feeling as physically strong as before. *"... I feel easily fatigued, lacking the energy to do anything."* - Patient #1, 64 years old, FSS 5.22 (Fatigue severity score=5.22).

1.2 Apathy and lack of motivation: Some participants said that they felt a lack of motivation. *" With multiple symptoms like dizziness, weakness, and palpitations, it makes me feel apathetic and not motivated. I feel like the post-COVID symptoms are a significant obstacle."* - Patient #25, 4 8 years old, FSS 6.11.

1.3 Lack of energy, emotionally drained, insomnia: Psychological impact was revealed in statements such as: *"....After recovering, I feel tired, exhausted, and can't sleep. I am afraid of what might happen. What did COVID-19 do to us? Why can't I sleep?"* - Patient #14, 64 years old, FSS 4.78.

1.4 Reduced ability to work affects family income and causes stress. Participants mentioned that having post-COVID symptoms resulted in having to stop working, leading to loss of income, reduced performance in family duties, and decreased work capacity.

"When I had COVID-19, I couldn't work and lost income. I couldn't sell goods. After recovering, I still had post-COVID symptoms. Some days, I couldn't go out to sell goods" – Patient #3, 39 years old, FSS 5.33.

2. The duration of post-COVID-19 symptoms

For some participants, post-COVID syndrome symptoms began around three months after recovering from COVID-19. The duration of long COVID was 2-12 months. Symptoms lasted for about a year: *"....Post-COVID symptoms have been going on for about a year. It started with a persistent dry cough for about a month. I lost my appetite for about two months.* - Patient #29, 65 years old, FSS 4.44.

3. Factors associated with PEM

Some participants reported experiencing significant post-activity fatigue, often coupled with elevated BMI, indicating that they were overweight or obese. Additionally, those who had suffered severe COVID-19 illness also exhibited symptoms of pneumonia.

3.1 Being female makes the body weaker and the lungs less resilient than males. *"I think women recover slower than men because their bodies are weaker. So, when they get sick, they take longer to heal. The symptoms of long COVID were lasting longer for women."* - Patient #12, 49 years old, FSS 4.

3.2 Obesity causes easy fatigue. *"...I suspect it's because I'm overweight and my lungs aren't strong. I get tired even after walking a short distance."* – Patient #22, 69 years old, BMI 28.0, FSS 4.89.

3.3 COVID-19 destroys the lungs. Some participants reported feeling fatigued due to various causes, including COVID-19 damaging the lungs. *"I feel very tired. I need oxygen even at home and I still coughing after the doctor discharged me…. The most important thing, COVID damages our lungs."* – Patient #14, 64 years old, FSS 6.22.

3.4 The severe symptoms of COVID-19 and advanced age resulted in a slow recovery process for my body. *"When I had COVID, it was severe. I had to be hospitalized for several days, felt extremely tired, had a high fever, and couldn't eat. It took a long time to recover, and my body recovered slowly. I felt weak, without energy, and being elderly made the recovery even more challenging."* - Patient 26, 85 years old.

3.5 Pre-existing lung disease aggravates symptoms. *"Having asthma along with COVID makes recovery slower. I feel easily tired. Now, it's even harder to recover. Symptoms worsen, especially shortness of breath."* - Patient #27, 69 years old, 4.33.

3.6 Underlying diseases cause lower immunity and weaken the body. *"Being diabetic makes my immunity low. Even after recovering, I still feel exhausted and weak. No recovery in immunity, always tired."* - Patient #2, 53 years old, FSS 4.67.

4. Self-care and treatment when experiencing post-COVID-19 condition

The participants reported using self-care strategies to monitor their symptoms, take rests, and reduce strenuous activities. They also consulted with family members, relatives, and friends when symptoms worsened or persisted for a longer period. Seeking healthcare services included purchasing over-the-counter medications, receiving treatment at private clinics, and accessing services from primary healthcare units, sub-district health promotion hospitals, and general hospitals. *"...I observe for any abnormal symptoms. If I feel fatigued easily, I discuss it with my children and relatives who have had COVID-19 to understand why. Then, I take care of myself by resting and avoiding strenuous activities."* - Patient, Female, 64 years old, FSS 6.22

5. Healthcare service needs when experiencing long COVID

Almost all participants provided information indicating that the existing service system was satisfactory. Some individuals expressed a desire for online consultation services and the implementation of a more convenient and expedited service system, reducing wait times.

Qualitative analysis Explains Quantitative Results

During the integration phase, we analyzed factors associated with PEM in post-COVID patients. In this phase, researchers integrated and analyzed data obtained from both quantitative and qualitative surveys to enhance understanding of post-COVID conditions and the impact of post-exertional malaise. We considered the consistency and differences between the data obtained from both phases. The results revealed that post-COVID condition is an experience of illness that occurs after recovering from COVID-19 for three months, with symptoms persisting between two months to one year. These symptoms manifest physically, psychologically, and socially, including post-exertional malaise, leading to anxiety, stress, and fear of the consequences of illness. This impacts the body's functionality, resulting in reduced activity levels and increased fatigue, consequently affecting work and the

economic status of families. Qualitative content analysis supported quantitative findings regarding factors influencing PEM in post-COVID patients. Factors such as female sex, obesity, and severity of COVID-19 illness have an impact on PEM in post-COVID patients.

DISCUSSION

This study followed up on post-COVID symptoms after recovering from COVID-19 for three months, according to the definition of long COVID by the World Health Organization.[9] We found that every individual in our sample group experienced more than one symptom and manifestations of post-COVID conditions, affecting various systems, including the respiratory, cardiovascular, nervous, gastrointestinal, skin, and others. The most common physical symptoms observed were being easily fatigued, followed by feeling weak or exhausted after activities, and chronic coughing, in that order. We also found that the majority of participants (61.22%) scored higher than or equal to four on the post-exertional fatigue severity scale (FSS). For mental and social symptoms, the most common were fear, followed by stress and worry, respectively. These findings are consistent with previous research indicating that post-COVID conditions involve more than one system, with the respiratory system being the most affected, impacting both physical and mental well-being.[10,13,17,31] This can be explained by the effects of the COVID-19 virus on the immune system, leading to injury and inflammation of tissues in various organs throughout the body, especially the lungs.[32] Regarding the duration of post-COVID symptoms, the majority of participants experienced symptoms for 2-3 months (66.37%), while 7.14% experienced symptoms for more than six months up to 1 year. This is consistent with a long-term follow-up study of 1 year by Cai et al. (2023), which found that some patients still experienced symptoms such as fatigue, weakness, insomnia, and hair loss.[10] Some individuals may experience symptoms for up to six months, while others may persist for over one year.[33,34]

Factors affecting PEM in patients with post-COVID conditions included female sex, BMI, and the severity of COVID-19 illness. Past studies have also found that females experienced more post-COVID problems and fatigue than males, potentially due to biological, and hormonal differences, and varying immune responses.[17,35,36] Additionally, sex, BMI, and severity of COVID-19 illness were found to have an impact on post-COVID conditions, likely due to increased inflammation and immune dysregulation.[19,31,37] Qualitative research findings supported by quantitative research emphasize the comprehensive impact of post-COVID conditions affecting not only physical health but also, mental, emotional, memory, and various functional abilities, including occupational performance. This aligns with the study by Lerer et al. which reported significant functional impairments in long COVID patients.[38]

Regarding self-care and treatment for post-COVID conditions, the sample group utilized self-care systems, such as symptom monitoring, resting, reducing strenuous activities, consulting family members, relatives, neighbors, and healthcare teams, purchasing medications, vitamins, or supplements, seeking self-treatment at private clinics, and receiving services at health promotion sub-district health centers. Our results were consistent with the literature review by Brown et al. which found that post-COVID patients managed their conditions either without medication or with medication to alleviate symptoms and resume work.[39] However, self-

management practices such as purchasing medications, supplements, and herbs for self-consumption may negatively impact the body's functions, particularly the kidneys and liver. Healthcare teams should know the importance of reviewing service system arrangements to enhance knowledge and understanding and assist patients in self-care and managing illness safely.

In conclusion, long COVID affects various aspects of patients' lives, including physical, mental, emotional, social, and economic well-being. PEM notably impacts exercise capacity, motivation, and physical abilities, with BMI, female sex, and illness severity being significant factors. Patients often use self-management practices, including medication, supplements, and herbal remedies, particularly those with chronic conditions. It is crucial to promote safe self-care and develop tailored service systems to meet the needs of post-COVID patients effectively.

The mixed-method research approach provided a comprehensive assessment of PEM, combining quantitative and qualitative data to offer a robust understanding of the condition. The study confirmed known factors like BMI, female sex, and illness severity while highlighting unique cultural and demographic influences specific to the Thai population. Despite the study's strengths, including rigorous data collection methods, limitations such as the small sample size and cross-sectional design may affect the generalizability and causality of findings.

RECOMMENDATIONS

Recommendations for utilizing the research findings include developing a healthcare service system tailored for post-COVID-19 patients. This system should focus mainly on women, individuals who are overweight, and those with severe COVID-19 symptoms. Healthcare providers should prioritize providing education and guidance on self-care practices to reduce PEM. Implementing continuous care systems at home is crucial for promoting lung recovery and providing comprehensive support, including counseling for stress, motivation, and anxiety management. Continuity of care is essential to ensure appropriate and safe patient care, preventing complications, and improving their quality of life. Additionally, preventive education should also be emphasized for individuals with high BMI and chronic non-communicable diseases to mitigate long-term effects. Recommendations for future research include studying advanced programs or counseling formats to reduce PEM in post-COVID patients.

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